3619

Dkt. 66307/JPW/FHB

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Wen Dong Song, et al.

Application No. : 10/059,941

Filed : January 29, 2002

For : METHOD AND APPARATUS FOR DEFLASHING OF INTEGRATED CIRCUIT PACKAGES

1185 Avenue of the Americas
New York, New York 10036
May 21, 2002

#7
PRIORITY PAPER
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Assistant Commissioner for Patents
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Sir:

TRANSMITTAL OF CERTIFIED COPIES OF EARLIER FILED FOREIGN APPLICATION AND CLAIM TO PRIORITY PURSUANT TO 35 U.S.C. §119

Applicants submit herewith certified copies of Singapore Patent Application No. 200106032-6 in Singapore on October 1, 2001, and cited in Applicant's Declaration pursuant to 37 C.F.R. §1.63.

Applicants hereby claim the benefit of the October 3, 2001 filing date pursuant to 35 U.S.C. §119 and 37 C.F.R. §1.55(a).

Respectfully submitted,

John P. White
Registration No. 28,678
Attorneys for Applicants
Cooper & Dunham LLP
1185 Avenue of the Americas
New York, New York 10036
(212) 278-0400

I hereby certify that this paper is being deposited this date with the U.S. Postal Service with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231.

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Reg. No. 28,678

Date

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SINGAPORE

This is to certify that the annexed is a true copy of the following Singapore patent application as filed in this Registry.

Date of Filing	:	1 OCTOBER 2001
Application Number	:	200106032-6
Applicant(s)	:	DATA STORAGE INSITUTE
Title of Invention	:	METHOD AND APPARATUS FOR DEFLASHING OF INTERGARTED CIRCUIT PACKAGES

Sharmaine Wu Shee Mei
Assistant Registrar
for REGISTRAR OF PATENTS
SINGAPORE

PATENTS FORM 1

SINGAPORE
PATENTS ACT
(CHAPTER 221)
PATENTS RULES

Rule 19

01 OCT 2001
200106032-6

The Registrar of Patents
Registry of Patents

REQUEST FOR THE GRANT OF A PATENT

THE GRANT OF A PATENT IS REQUESTED BY THE UNDERSIGNED ON THE BASIS OF THE PRESENT APPLICATION

I. Title of Invention	**METHOD AND APPARATUS FOR DEFLASHING OF INTEGRATED CIRCUIT PACKAGES**	
II. Applicant(s) *(See note 2)*	(a) Name	**DATA STORAGE INSTITUTE**
	Body Description/ Residency	A company limited by guarantee
	Street Name & Number	DSI Building, 5 Engineering Drive 1 (off Kent Ridge Crescent, NUS)
	City	
	State	
	Country	Singapore 117608
	(b) Name	
	Body Description/ Residency	
	Street Name & Number	
	City	
	State	
	Country	
	(c) Name	
	Body Description/ Residency	
	Street Name & Number	
	City	
	State	
	Country	

0 1 OCT 2001
200106032-6

III. Declaration of Priority *(see note 3)*	Country/Country Designated		File No.	
	Filing Date			
	Country/Country Designated		File No.	
	Filing Date			
	Country/Country Designated		File No.	
	Filing Date			

IV. Inventors *(see note 4)*				
(a) the applicant(s) is/are the sole/joint inventor(s)	☐	**Yes**	☒	**No**
(b) A statement on Patents Form 8 is/will be furnished.	☒	**Yes**	☐	**No**

V. Name of Agent (if any) *(See note 5)*	**ALLEN & GLEDHILL**

VI. Address for Service *(See note 6)*	Block/Hse No.	36	Level No.	18
	Unit No./PO Box	01	Postal Code	068877
	Street Name	**ROBINSON ROAD**		
	Building Name	**CITY HOUSE**		

VII. Claiming an earlier filing date under Section 20(3), 26(6) or 47(4). *(See note 7)*	Application No.	
	Filing Date	

[Please tick in the relevant space provided]:

( ) Proceeding under rule 27(1)(a).

Date on which the earlier application was amended =

or ______________

( ) Proceeding under rule 27(1)(b).

0 1 OCT 2001
200106032-6

VIII. Invention has been displayed at an International Exhibition *(See note 8)*	☐ Yes ☒ No
IX. Section 114 requirements *(See note 9)*	The invention relates to and/or used a micro-organism deposited for the purposes of disclosure in accordance with Section 114 with a depository authority under the Budapest Treaty ☐ Yes ☒ No

X. Check List
(To be filled in by applicant or agent)

A. The application contains the following number of sheet(s):-

1. Request	4	Sheets
2. Description	7	Sheets
3. Claim(s)	3	Sheets
4. Drawing(s)	5	Sheets
5. Abstract	1	Sheets

B. The application as filed is accompanied by:-

1. Priority document	
2. Translation of priority document	
3. Statement of Inventorship & right to grant	X
4. International Exhibition certificate	

XI. Signature(s) *(See note 10)*

Applicant (a)	[signature]	
Date	1 October 2001	
Applicant (b)		
Date		
Applicant (c)		
Date		

01 OCT 2001
200106032-6

NOTES:

1. This form when completed, should be brought or sent to the Registry of Patents together with the prescribed fee and 3 copies of the description of the invention, and of any drawings.

2. Enter the name and address of each applicant in the spaces provided at paragraph II. Names of individuals should be indicated in full and the surname or family name should be underlined. The names of all partners in a firm must be given in full. The place of residence of each individual should also be furnished in the space provided. Bodies corporate should be designated by their corporate name and country of incorporation and, where appropriate, the state of incorporation within that country should be entered where provided. Where more than 3 applicants are to be named, the names and address of the fourth and any further applicants should be given on a separate sheet attached to this form together with the signature of each of these further applicants.

3. The declaration of priority at paragraph III should state the date of the previous filing, the country in which it was made, and indicate the file number, if available. Where the application relied upon in an International Application or a regional patent application e.g. European patent application, one of the countries designated in that application [being one falling under the Patents (Convention Countries) Order] should be identified and the name of that country should be entered in the space provided.

4. Where the applicant or applicants is/are the sole inventor or the joint inventors, paragraph IV should be completed by marking the "YES" Box in the declaration (a) and the "NO" Box in the alternative statement (b). Where this is not the case, the "NO" Box in declaration (a) should be marked and a statement will be required to be filed on Patents Form 8.

5. If the applicant has appointed an agent to act on his behalf, the agent's name should be indicated in the spaces available at paragraph V.

6. An address for service in Singapore to which all documents may be sent must be stated at paragraph VI. It is recommended that a telephone number be provided if an agent is not appointed.

7. When an application is made by virtue of section 20(3), 26(6) or 47(4), the appropriate section should be identified at paragraph VII and the number of the earlier application or any patent granted thereon identified. Applicants proceeding under section 26(6) should identify which provision in rule 27 they are proceeding under. If the applicants are proceeding under rule 27(1)(a), they should also indicate the date on which the earlier application was amended.

8. Where the applicant wishes an earlier disclosure of the invention by him at an International Exhibition to be disregarded in accordance with section 14(4)(c), then the "YES" Box at paragraph VIII should be marked. Otherwise the "NO" Box should be marked.

9. Where in disclosing the invention the application refers to one or more micro-organisms deposited with a depository authority under the Budapest Treaty, then the "YES" Box at paragraph IX should be marked. Otherwise, the "NO" Box should be marked.

10. Attention is drawn to rules 90 and 105 of the Patent Rules. Where there are more than 3 applicants, see also Note 2 above.

11. Applicants resident in Singapore are reminded that if the Registry of Patents considers that an application contains information the publication of which might be prejudicial to the defence of Singapore or the safety of the public, it may prohibit or restrict its publication or communication. Any person resident in Singapore and wishing to apply for patent protection in other countries must first obtain permission from the Singapore Registry of Patents unless they have already applied for a patent for the same invention in Singapore. In the latter case, no application should be made overseas until at least 2 months after the application has been filed in Singapore.

For Official Use

Application Filing Date : / /
Request received on : / /
Fee received on : / /
Amount :
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Method and apparatus for deflashing of integrated circuit packages.

This invention relates to a method and apparatus for laser deflashing of integrated circuit (IC) packages. In particular, it relates to a method and apparatus for removing flash from heat sinks as well as leads and bars in IC packages without damage.

A plastic-encapsulated microcircuit consists of an IC chip physically attached to a leadframe, electrically interconnected to input-output leads mid moulded in a plastic that is in direct contact with the chip, leadframe, and interconnects. With major advantages in cost, size, weight, performance, and availability, plastic packages have attracted 97% of the market share of worldwide microcircuit sales.

During the moulding process, it is known that moulding compound can flow through the mould parting line and onto the leads of the device. In its thinnest form, this material is known as resin bleed or thin flash. A thicker bleed of material is known as flash. If this material is left on the leads it will cause problems in the downstream operations of lead trimming, forming, and solder dipping and/or plating. In some cases, plastic packages are designed with an integral heat spreader exposed to air to meet high thermal and electrical performance demands. The die is attached directly to the heat spreader to minimize the thermal resistance. During the moulding process, moulding compound usually leaks out and forms flash on heat sink surfaces. This will greatly limit heat sink function and even cause damage of the plastic packages. Therefore, deflashing of IC packages is one of critical processes in the manufacturing.

Mechanical and chemical deflashing are conventional deflashing techniques in IC packaging lines. For removing resin bleed or thin flash, it is excellent to use chemical deflashing technique. Plastic packages are immersed in a chemical tank for a specified time and checked for the degree of deflashing. Effectively deflashed components are rinsed and air-dried. However, it has distinct drawbacks. First, chemical solution used for deflashing can potentially hurt component performance. Second, there is the

significant cost of handling and disposing toxic materials during and after deflashing Mechanical deflashing techniques such as suction gun, pressure gun, wet blast and impeller wheel are usually used to remove flash on round leads, heat sinks and lead frames, and flash between tie bars and leads. However, it also has distinct drawbacks as shown in R. F. Zecber "Deflashing encapsulated electronic components"; Plastics Engineering, June (1985), pp. 35-38. For example, some dust is needed to clean up.

Laser deflashing as a new deflashing technique was disclosed in US patents Nos. 5099101 and 5961860, and Singapore patent WO 00/37209. In above patents, YAG laser or excimer laser is used to remove flash. Since heat sinks as well as leads and bars are made of copper or copper substrate with metal coating layers, YAG laser or excimer laser easily induces damage of heat sinks as well as leads and bars in air at high laser fluence. Our new findings indicate that as flash especially thick flash has been removed by YAG or excimer laser ablation, the laser also induces damage such as oxidation of heat sinks as well as leads and bars. In fact, only thin flash can be removed by YAG or excimer laser deflashing at low laser fluence and pulse number without damage such as oxidation of heat sinks as well as leads and bars. Therefore, how to remove flash without damage is key issue for laser deflashing application in industry

In accordance with a first aspect of the present invention there is provided a method of deflashing IC packages. The method comprises the steps of directing a first laser beam in the infra-red frequency range onto flash area for removing top layer of flash; and subsequently directing a second pulsed laser beam onto the flash area at low laser fluence and pulse number for removing the thin layer of flash remained after application of the first laser beam.

Since heat sinks as well as leads and bars are high reflective materials to infra-red radiation, the first laser irradiation only induces low temperature rise of the heat sinks, leads and bars. In addition, the thin layer of flash remained after the first laser deflashing plays an important part in avoiding damage such as oxidation. Therefore, the damage can be effectively avoided during the first laser deflashing. when infra-red laser irradiates the flash area. The first laser can effectively remove top layer of flash especially thick flash. However, a thin layer of flash remains on heat sinks as well as

leads and bars after the first laser deflashing. That means that the first laser deflashing on its own cannot meet industrial demands. To complete effective deflashing, the second laser is applied deflashing at low laser fluence and pulse number can effectively remove the thin flash remained after the first laser deflashing without damage in accordance with this invention.

The first laser may, for example, by a CO_2 laser. It may applied in pulses, each with a typical duration in excess of 1 μs. Alternatively, it may be applied in a continuous wave (CW) mode.

The second laser may operate over a wide spectral range, for example, from infra-red to ultra-violet. It may suitably be a YAG laser. The second laser is, most preferably, applied in short-duration pulses. It has been found that a pulse length of less than 100ns is to be preferred to produce effective deflashing, without causing a significant and detrimental temperature rise in sensitive components, such as leads and bars, of the IC at low laser fluence and pulse number.

In accordance with a second aspect of the present invention, there is provided an apparatus for deflashing IC packages comprising: a conveyor system for carrying IC packages to appropriate position; a mask placed on IC packages for exposing flash area to laser beams; first and second lasers for generating laser beams; and a scanning system for each laser; wherein the belt conveyor is movable relative to each laser beam, the two galvanometers being used to scan respective laser beams in turn on a flash area of the IC packages.

With the present invention, the damage of heat sinks as well as leads and bars can be effectively avoided; the flash on heat sinks as well as leads and bars can be effectively removed by laser irradiation.

Apparatus embodying the invention may further comprise an exhauster for removing flash debris.

The first laser may be a CO_2 laser. Moreover, the first laser may be a pulsed laser or a continuous wave laser.

The second laser is typically a YAG laser. The second laser may have a wavelength of 1064 nm or 532 nm.

In typical embodiments, the second laser has predetermined pulse-duration. For example, the predetermined pulse duration is between 1 fs and 1000 ns; e.g. 7 ns.

Embodiments of the invention will now be described in detail, by way of example, and with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing the apparatus according to one embodiment of the present invention;

Figure 2a is a microscope photo showing a sample of heat sink in an IC package deflashed by a prior deflashing method using YAG laser irradiation at 300 mJ/cm^2;

Figure 2b is a microscope photo showing another part of the same sample deflashed by a prior deflashing method using YAG laser irradiation at 300 mJ/cm^2;

Figure 3a is a microscope photo showing a sample of heat sink in an IC package deflashed by a prior deflashing method using YAG laser irradiation at 720 mJ/cm^2;

Figure 3b is an X-ray photoelectron spectroscopy (XPS) Cu2p spectrum of Fig. 3a;

Figure 4a is a microscope photo showing a sample of heat sink in an IC package deflashed by the method of the present invention using $C0_2$ and YAG laser deflashing.

Figure 4b is an X-ray photoelectron spectroscopy (XPS) Cu2p spectrum of Fig. 4a;

Figure 5a is a microscope photo showing a sample of heat sink in an IC package deflashed by the method of the present invention using CO_2 laser deflashing;

Figure 5b is a microscope photo showing be same sample of Fig 5a deflashed by the method of the present invention using YAG laser deflashing; and

Figure 5c is an X-ray photoelectron spectroscopy (XPS) Cu2p spectrum of Fig. 5b.

Refer now to Figure 1. The apparatus for deflashing IC packages according to one embodiment of the present invention comprises a first laser 10. The first laser is a CO_2

laser that generates a laser beam 20 in the infra-red range, in this embodiment, with a wavelength of approximately 10.6 μm.

A galvanometer 30 for first laser 10 is used to scan the CO_2 laser beam 20 onto an IC package 40 along a predetermined path. A mask 50 is used to expose only the flash area on the IC package 40 to laser beam 20. The IC package 40 with the mask 50 is placed on belt conveyor subsystem 60. After the first laser deflashing, the IC package 40 is carried from position A to position B by the belt conveyor subsystem 60 for following a second laser deflashing operation. Meanwhile, another IC package can be carried to position A for its first laser deflashing.

A second laser 70 is in this embodiment, a YAG laser for generating a YAG laser beam 80 having a wavelength of 532 nm or 1064nm. A galvanometer 90 for the second laser 70 is used to scan the YAG laser beam 80 onto the IC package 40 as it passes along its predetermined path.

An exhauster 100 is used to take away flash debris removed by CO_2 and YAG laser deflashing. A gas blower 110 is also provided to reduce heating of the IC packages by blowing gas, such as compressed air or N_2 gas through a nozzle onto the packages.

As shown in Figures 2a and 2b, one sample of heat sink was deflashed according to a prior art laser deflashing method. A YAG laser was used with a wavelength of 532 nm. The pulse duration is 7 ns. The laser fluence was 300 mJ/cm^2 and pulse number is 4. At an irradiated area 210, fresh heat sink surface can be seen. A thin layer of flash exists at non-irradiated area 220 as shown in Figure 2a. This indicates that thin flash can be easily removed by YAG laser deflashing. However, a thick layer of flash at irradiated area 230 in Figure 2b cannot be removed by YAG laser deflashing at 300 mJ/cm^2 and 4 pulses.

Figure 3a is a microscope photo showing an sample of heat sink in an IC package deflashed by a prior art deflashing method using YAG laser irradiation at 720 mJ/cm^2 and 10 pulses. Although thick flash in area 250 has been removed, damage to the heat sink surface has taken place. Figure 3b is an X-ray photoelectron spectroscopy (XPS) Cu2p spectrum of the same sample of Figures 3a and 3b a after YAG laser deflashing at

a wavelength of 532 nm, a laser fluence of 720 mJ/cm^2 and a pulse number of 10. Four peaks are observed in the XPS Cu2p spectrum as shown in Figure 3b. This indicates that damage such as oxidation of heat sink has taken place. Comparing Figures 2 and 3, we can conclude that a YAG laser can only remove thin flash without damage at low laser fluence and pulse number. A YAG laser cannot remove thick flash without damage. The same effect was observed after deflashing using an excimer laser.

Figure 4a is a microscope photo showing a sample of heat sink in an IC package deflashed by the method of the present invention in apparatus described with reference to Figure 1. A first laser deflashing operation was carried out using the first laser 10 at a power of 10 W, pulse duration of 20 µs, a repetition rate of 2000 Hz and a scan speed of 5 mm/s. Subsequently, a second deflashing operation was performed using a the YAG laser 70 at a wavelength of 532 nm, a laser fluence of 300 mJ/cm^2 and a pulse number of 4. As shown in Figure 4a, flash in area 260 has been removed by the method of the present invention without damage. Figure 4b is an XPS Cu2p spectrum of the same sample of Figure 4a. Comparing the XPS Cu2p spectrum of the heat sink with the standard XPS spectra of Cu2p observed in copper, cuprous oxide and cupric oxide, it was found that the XPS Cu2p spectrum of the heat sink is the same as the standard XPS Cu2p spectrum of copper. Therefore, no damage such as oxidation of the heat sink surface has taken place by the deflashing operation embodying the invention.

Figure 5a is a microscope photo showing a sample at heat sink in an IC package deflashed by the method embodying the present invention using CO_2 laser deflashing. The heat sink is made of copper. The pulse duration is 20 µs and the repetition rate is 2000 Hz. The power is 10 W and scan speed is 5 mm/s. It is found that top layer of flash in area 270 has been removed and a thin layer of flash still exists on the heat sink surface. Figure 5b is a microscope photo showing the same sample of Figure 5a deflashed by the method of the present invention using YAG laser deflashing. The laser fluence is 400 mJ/cm^2 and pulse number is 2. The laser wavelength is 1064nm and pulse duration is 7ns. It was observed that the thin flash remained on the heat sink after CO_2 laser deflashing has been removed without damage as shown in area 280 of Figure 5b. Figure 5c is an XPS Cu2p spectrum of the same sample of Figure 5b. Comparing the XPS Cu2p spectrum of the heat sink surface with standard XPS spectra of Cu2p

observed in copper, cuprous oxide and cupric oxide, it was found that XPS Cu2p spectrum of the heat sink surface is the same with standard XPS Cu2p spectrum of copper. Therefore, no damage such as on oxidation of the heat sink surface has taken place. Therefore, the present invention can be used to effectively remove thin or thick flash without damage.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore to be embraced therein.

Claims:

1. A method of deflashing IC packages comprising the steps of:

   directing a first laser beam in the infra-red frequency range onto flash area for removing top layer of flash; and subsequently

   directing a second pulsed laser beam onto the flash area at low laser fluence and pulse number for removing the thin layer of flash remained after application of the first laser beam.

2. A method according to claim 1, wherein the first laser is a CO_2 laser.

3. A method according to claim 1 or claim 2 in which the first laser beam has a wavelength of approximately 1064 nm.

4. A method according to any preceding claim in which the first laser is operated in pulses of length in excess of 1 μs.

5. A method according to claim 4 in which the first laser is operated in continuous wave mode.

6. A method according to any preceding claim in which the first laser has an intensity of approximately 10kw/cm^2.

7. A method according to any preceding claim in which the second laser is a YAG laser.

8. A method according to claim 7 in which the second laser has a wavelength that is between ultra-violet and infra-red.

9. A method according to claim 8 in which the second laser has a wavelength of approximately 532 nm or 1064nm.

10. A method according to any preceding claim in which the second laser is operated in pulses.

11. A method according to claim 10 in which the pulse duration is between one fs and 1000 ns.

12. A method according to claim 11 in which the pulses are of duration not greater than 100ns.

13. A method according to any preceding claim in which the second laser has a fluence of less than 1000 mJ/cm^2.

14. A method according to claim 13 in which the second laser has a fluence of approximately 300 mJ/cm^2.

15. An apparatus for deflashing IC packages comprising:

a. a conveyor system for carrying IC packages to appropriate position;

b. a mask placed on IC packages for exposing flash area to laser beams;

c. first and second lasers for generating laser beams; and

d. a scanning system for each laser;

wherein the conveyor is movable relative to each laser beam, the two galvanometers being used to scan respective laser beams in turn on a flash area of the IC packages.

16. Apparatus according to claim 15 further comprising an exhauster for removing flash debris.

17. Apparatus according to claim 15 or claim 16 in which the first laser is a CO_2 laser.

18. Apparatus according to any one of claims 15 to 17 in which the first laser is a pulsed laser.

19. Apparatus according to any one of claims 15 to 17 in which the first laser is a continuous wave laser.

20. Apparatus according to any one of claims 15 to 19 in which the second laser is a YAG laser.

21. Apparatus according to any one of claims 15 to 20 in which the second laser has a wavelength of 1064 nm or 532 nm.

22. Apparatus according to any one of claims 15 to 21 in which the second laser has predetermined pulse-duration.

23. Apparatus according to claim 22 in which the predetermined pulse duration is between 1 fs and 1000 ns.

24. A method of deflashing integrated circuit packages substantially as herein described with reference to the accompanying drawings.

25. An apparatus for deflashing IC packages substantially as herein described with reference to the accompanying drawings.

Abstract

Method and apparatus for deflashing of integrated circuit packages.

This invention relates to a method and apparatus for deflashing integrated circuit (IC) packages by laser irradiation. The method and apparatus include two lasers scanning flash area for performing deflashing operation. CO_2 laser is used to remove top layer of flash and YAG laser is used to remove the thin layer of flash remained after $C0_2$ laser deflashing. CO_2 laser deflashing and following YAG laser deflashing can effectively remove flash and avoid damage of heat sinks as well as leads and bars in the IC packages.

Fig. 1

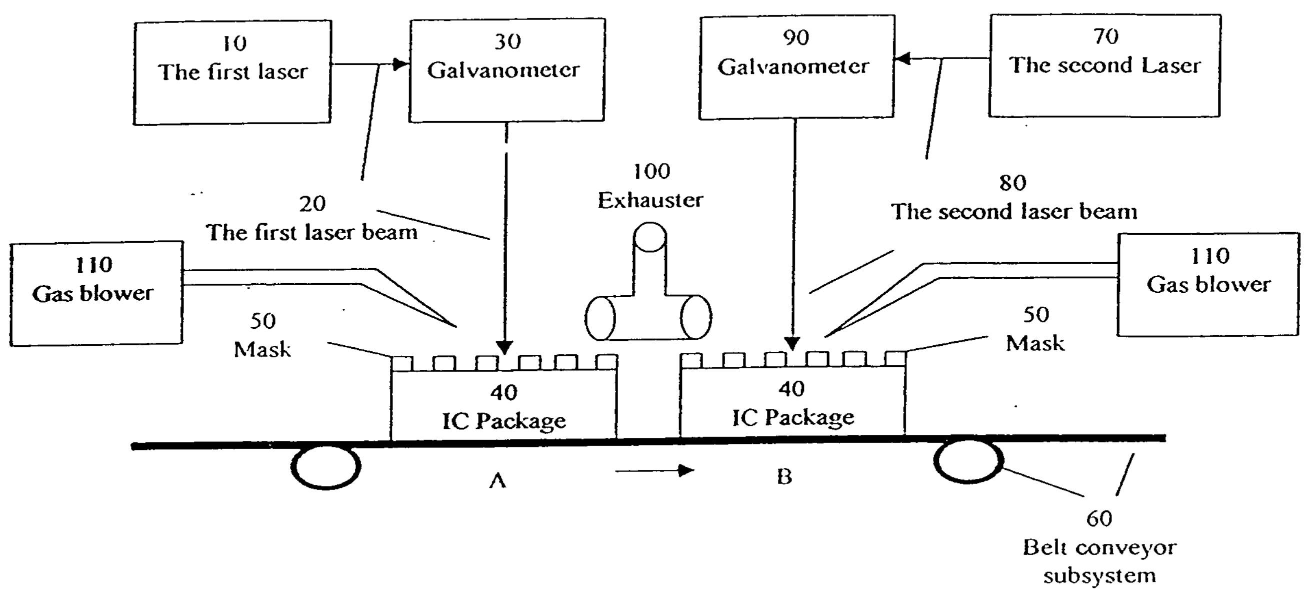
10
The first laser
30
Galvanometer
90
Galvanometer
70
The second Laser
100
Exhauster
20
The first laser beam
80
The second laser beam
110
Gas blower
110
Gas blower
50
Mask
50
Mask
40
IC Package
40
IC Package
A
B
60
Belt conveyor
subsystem

Fig. 1

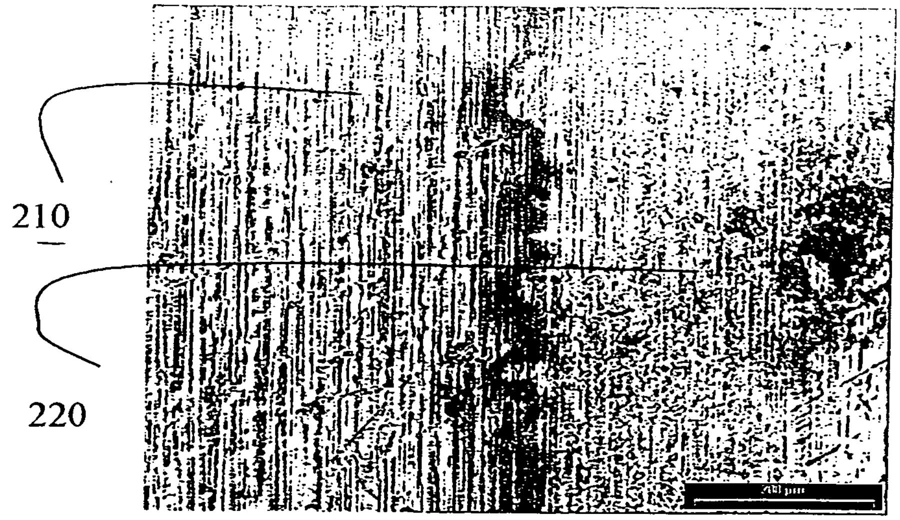

Fig. 2a

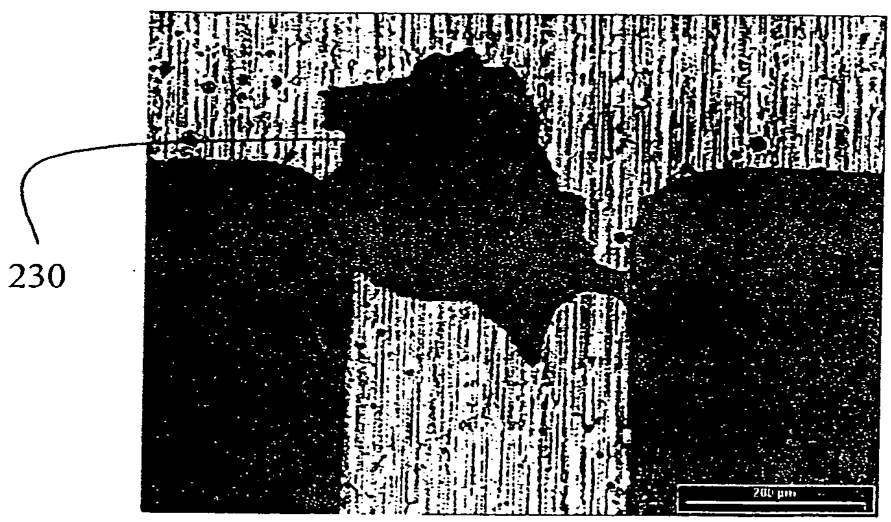

Fig. 2b

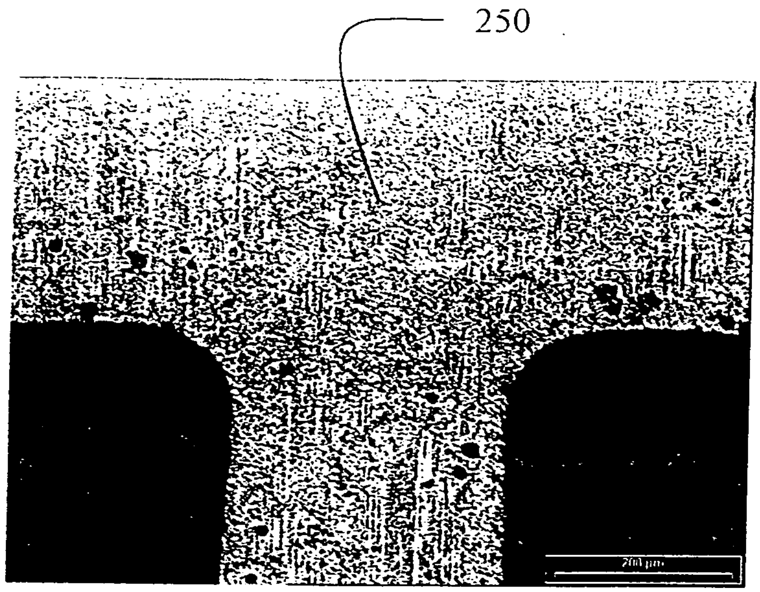
250
200 µm

Fig. 3a

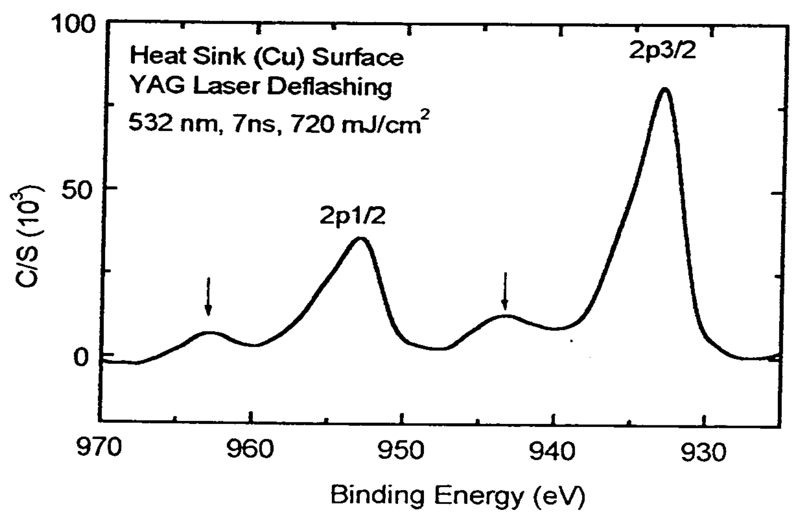
Heat Sink (Cu) Surface
YAG Laser Deflashing
532 nm, 7ns, 720 mJ/cm2
2p3/2
2p1/2
100
50
0
C/S (10³)
970
960
950
940
930
Binding Energy (eV)

Fig. 3b

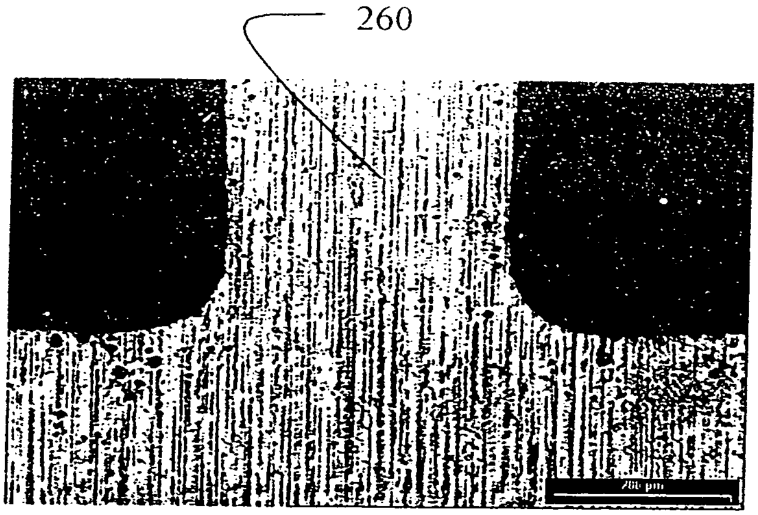
260

Fig. 4a

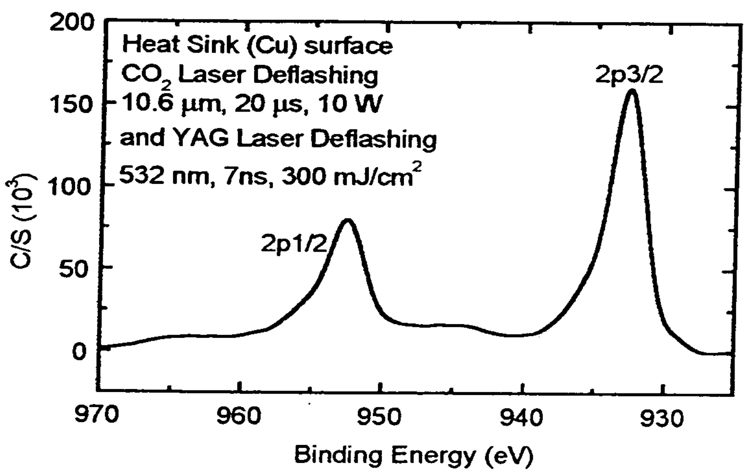
Heat Sink (Cu) surface
CO_2 Laser Deflashing
10.6 μm, 20 μs, 10 W
and YAG Laser Deflashing
532 nm, 7ns, 300 mJ/cm^2
2p3/2
2p1/2
C/S (10^3)
200
150
100
50
0
970
960
950
940
930
Binding Energy (eV)

Fig. 4b

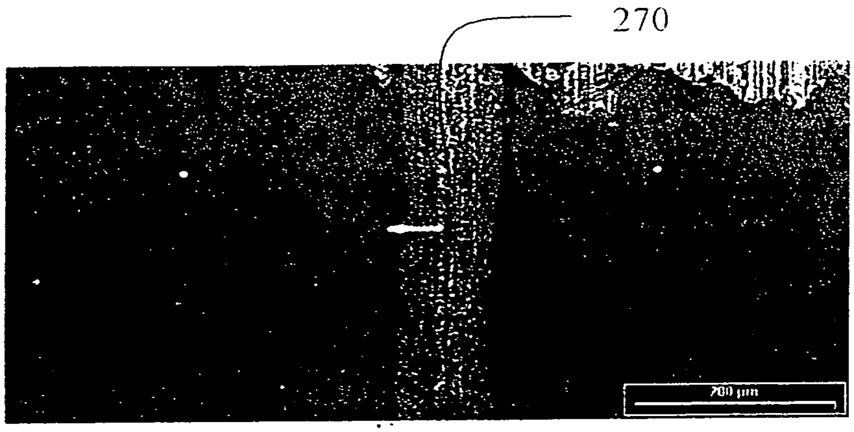

Fig. 5a

Fig. 5b

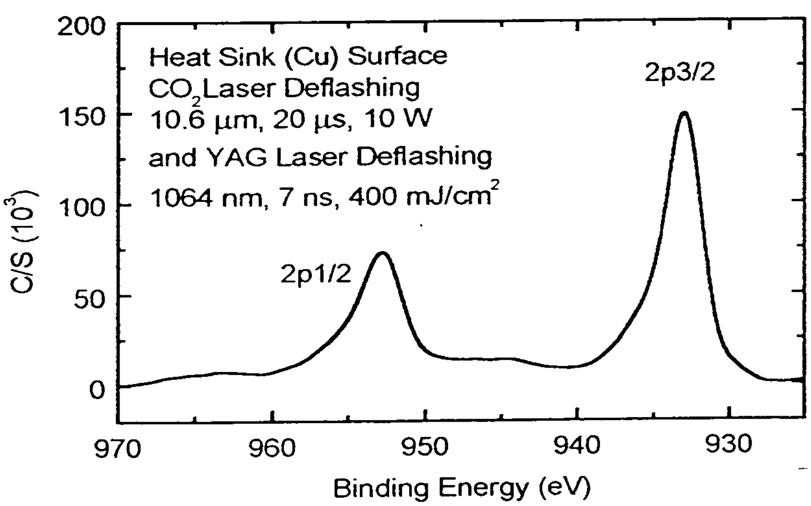

Fig. 5c